A NEW SETT OF

Logarithmic Solar Tables,

Calculated and conſtructed for determining the

LATITUDE at SEA,

BY

Taking two Altitudes either in the Forenoon or Afternoon, with the intermediate Time by a common Watch; and that with Eaſe and Accuracy, independent of the Sun's Meridional Altitude.

THIS MOST

Excellent and Uſeful Performance, does not only produce the true Latitude at any Time between Nine o'Clock in the Morning, and Three in the Afternoon; but alſo gives the true Time of the Day, when the greateſt Altitude was taken to thirty Seconds by the Tables; and if a greater Degree of Accuracy is required, the ſame may be done by taking Proportional Parts.

WHENCE THE

SUN's true AZIMUTH may be determined by One ſingle Proportion.

LONDON:
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on *Tower-Hill.* 1759.

The Proprietors to the Public.

THESE Tables were offered to us by Mr. *Richard Harriſon*, whoſe Name is ſubſcribed to the Preface aforegoing, who aſſures us in the ſtricteſt Manner, that he obtained them in Manuſcript from an *Hollander*, and that they have never been publiſhed: We therefore being deſirous to promote and encourage whatever has a tendency to improve the Practice of *Navigation*, have purchaſed them of him, and hope they will prove acceptable to the Public, by anſwering the Purpoſes intended.

PREFACE DEDICATORY.

To the Honourable the

Admirals, Commodores and Captains in the ROYAL-NAVY, and worthy Commanders of Ships in the MERCHANTS Service.

SIRS,

AS Trade and Navigation are the grand Sourſe of Riches and Power, ſo is the Royal-Navy the Protection of Commerce, and the Preſervation (under Providence) of the Liberties, Rights and Privileges of the *Britiſh* Nation, againſt the Attempts of its invidious Enemies: Every real Improvement therefore in Navigation, juſtly Merits the Attention of the Public, particularly of thoſe who are more immediately concerned in the ſame; and that this uſeful Diſcovery will be found, by general Practice and Experience, to have a juſt Claim hereunto, and that in an eminent Degree, I am fully aſſured by my own; I ſhall not therefore in this Preface make any further Comment upon its Utility, but only take Notice of a few Particulars antecedent, and then proceed to exhibit ſuch plain and eaſy Inſtructions and Directions in the Application and Uſe, as that the ſame may (by once carefully reading over) become intelligible and familiar, even to ſuch who are only acquainted with the common Rudiments of Navigation.

This late Improvement is in no wiſe confined to any particular Inſtrument for taking the Sun's Altitude, although the beſt for that purpoſe are certainly to be preferred: I have alſo added a Table of Allowances for Heights above the Surface of the Water, and another of Refraction, which laſt at ſome particular Times is more eſſentially to be conſidered and allowed, as hereafter I have noticed.

It is not intended that this ſhould or ought to deſtroy the uſual Method of finding the Latitude by Meridional Obſervations; it will certainly be right to take theſe as often as they can be taken, if it is only for the Satisfaction of comparing the Agreement; but it frequently happens that this cannot be obtained by reaſon of foggy Weather, a Squal, or the interpoſition of a Cloud, eſpecially when near the Land; and after a long Voyage for want of the true Latitude it too often proves fatal; whereas, if the true Latitude was known, a true Courſe could be ſhaped accordingly, (proper Allowances for Variation being made, and if Obſervations of the Variation cannot be had, there is an accurate Chart for that purpoſe lately conſtructed by Mr. *William Mountaine*, F.R.S. and Sold by Meſſ. *Mount* and *Page*, on *Tower-hill*,) and a good Landfall made, or the great Dangers of a narrow Channel avoided.

This new Invention has had a thorough Inſpection and Tryal on board ſome of His Majeſty's Ships of War, and has been approved as the moſt exact and accurate Method that ever appeared for this purpoſe, and is by thoſe to whom it was communicated for Tryal, kept as a great Secret; yet notwithſtanding this great Secrecy, it has been delivered from one Friend to another for further Experiment, who greatly avail themſelves of this Curioſity and Performance, and endeavour to diſtinguiſh themſelves thereby, on which Account I think it ought not to be retained any longer, but that the ſame deſerves, and ought to be publiſhed for general Service.

I do then hereby declare, that although I have publiſhed this Matter, yet I am not the firſt Inventor of theſe Tables, but have had ſo much Experience in regard to the Practical Part and Improvements in them, that I can ſufficiently teſtify the Truth thereof in real Practice.

The Determination of Longitude at Sea has been long attempted, but never yet rendered practicable, (that I know of) yet it is well known, that if ſuch a Thing as an Automaton could be conſtructed, that would keep true regular Time (for which Mr. *Harriſon* bids the faireſt) it would be of the greateſt Utility in this reſpect; yet then, this would not avail, unleſs the true Time of the Day could be had, but the true Time of the Day cannot always be obtain'd, even by a Meridional Obſervation, for it is well known to thoſe of Experience, that the apparent Velocity of the Sun, or the Alteration in his Altitude, (eſpecially in Latitudes approaching his Zenith) is ſo ſmall, that he appears almoſt ſtationary for ſome Time, whence the true Time of his paſſing the Meridian cannot be be exactly or accurately adjuſted by this means.

And as a ſmall Error in Time, makes a conſiderable Error in Longitude, that is, as 15d. of Longitude is to one Hour, or as one Minute of Time to 15 Miles in Longitude, it may happen to be of a very bad Conſequence, if the true Time of Noon be not duly adjuſted.

But if the true Time of the Day can be exactly found, then by ſuch Machine the Longitude of the Place is preciſely fixed: Hence ariſes the further very great Advantages of theſe Tables, as beſides the Latitude they determine the exact and true Time of the Day, when the greateſt Altitude is taken, by purſuing the following Directions, and which I here recommend for the public Good and Safety of Navigation, which are the hearty Wiſhes of,

SIRS,

Your moſt obedient and

Very humble Servant,

Richard Harriſon,
Of *Whitehaven.*

INSTRUCTIONS to the READER.

IT is to be obſerved in the firſt Place, that Natural Sines are made Uſe of in the Performance of this Work; and as the Tables hereof are not very common, I ſhall ſhew the Practitioner how to find them by the common Tables of Logarithms and Artificial Sines, exact to four Places of Figures, which will anſwer the End for Computation of the Latitude to one Minute or two, and regulating the Time to 30 Seconds; but they that require a greater Degree of Accuracy, muſt furniſh themſelves with thoſe Tables beforementioned.

How to find the Natural Sines.

Firſt, Enter the Tables of Artificial Sines, with the Degrees and Minutes given; take thoſe Figures anſwering thereto, only ſubſtituting 2 for the Index, and therewith enter the Tables of Logarithms, and find the ſaid Figures, or the neareſt thereunto, the correſponding Number is the Natural Sine of the Degrees and Minutes given: For further Illuſtration take an

EXAMPLE.

Let it be required to find the Natural Sine of 54d. 07m?

The Artificial Sine of 54d. 07m. is ———————— 9.908599

Enter the Table of Logarithms with the ſaid Figures, only retaining 2 for the Index, and the neareſt Log. is 2.908592, whoſe correſponding Number is 8102, the Natural Sine required exact to four Places.

Secondly, To find the Degrees and Minutes anſwering to any given Natural Sine.

This is done by reverſing the former Rule.

EX-

EXAMPLE.

Let 8171 *be the Natural Sine given, to find the correſponding Degrees and Minutes?*

The Logarithm of 8171 you will find to be 2.912275; ſubſtitute 9 for the Index, inſtead of 2, and find the ſaid Number, or the neareſt thereto, in the Artificial Sines, which is 9.912299, whoſe correſponding Degrees and Minutes are 54d. 48m.

Thirdly, It may be neceſſary to explain what is meant by the Term, *Secant leſs Radius*, an *Expreſſion* uſed in the following Work.

Find the Artificial Secant of the Degrees and Minutes given, and therefrom ſubtract or expunge 10 from the Index, the remaining Decimals will be the Secant leſs Radius.

EXAMPLE.

What is the Secant leſs Radius of 46d. 50m. ?

Enter the Table of Secants with 46d. 50m. gives 10.164866, expunge or cancel 10 from the Index, leaves 0.164866, which is the Secant leſs Radius of 46d. 50m.

Fourthly, To find the Logarithm Ratio.

It is to be obſerved, that in the following Operations, a ſuppoſed Latitude muſt be one of the Terms or Things given, in order to find the true Latitude and Time of the Day: This ſuppoſed Latitude, muſt be your Latitude by Account when you take the Sun's Altitudes; but yet it does not require ſuch an exact Computation, as to caſt up the Log-Board, an Eſtimation made by inſpecting the Courſes and Diſtances from laſt Noon will be ſufficient, ſince an Error of 15 or 20 Minutes will in no wiſe affect the Latitude found by this New Invention, worthy of Notice; for if you deſignedly make an Error of one, two or three Degrees, and repeat the Work two or three times, ſtill making uſe of the Latitude laſt found, for your ſuppoſed Latitude in the next Operation, it will at laſt diſcover itſelf to be the true, by being equal to the laſt Suppoſition, which evidently ſhews the excellency of theſe *New Solar Tables*, preferable to any Methods heretofore made uſe of for theſe Purpoſes; but to proceed to the Logarithm Ratio.

To the Secant leſs Radius of the ſuppoſed Latitude, add the Secant leſs Radius of the Sun's Declination for that Day, the Sum gives the Logarithm Ratio.

EXAMPLE.

Let the ſuppoſed Lat. be 46d. 50m.	Sec. leſs Rad.	0.16486
And the Sun's Dec. — 11d. 17m.		0.00847
The Logarithm Ratio		0.17333

Fifthly, Due Regard muſt be had to the Times when the Sun's Altitudes were taken, and if both the Altitudes were taken in the Forenoon, they muſt be ſubtracted from each other, and half that Difference is called *half the Difference of elapſed Time*; but if one Altitude be taken in the Forenoon, and the other in the Afternoon, then to the Time in the Afternoon add 12h. and ſubtract gives the intermediate Time as before; and as in this laſt Caſe, ſome Difference of Longitude may be made between the Obſervations, you muſt allow for the ſame in Proportion, as 15 Miles of Longitude is to one Minute of Time, and ſubtract that from the Time elapſed between the Obſervations, if ſailing to the Weſtward, but add, if ſailing to the Eaſtward.

EXAMPLE in each CASE.

Firſt, Both Altitudes in the Forenoon.

The firſt at	10h. 02m.
The ſecond at	11h. 27m.
Subtract is elapſed Time	01h. 25m.
Half elapſed Time	00h. 42m. 30 ſec.

Secondly, *Sailing Weſterly*,

The firſt Altitude, Forenoon ——— 10h. 26m.
The ſecond Alt. Afternoon 2h. 43m. 14h. 43m.

Subtract ——————————— 04h. 17m.
Diff. Lon. made is 30m. W. equal to 00h. 02m.

Subtract is the elapſed Time——— 04h. 15m.

Half the elapſed Time ———— 02h. 07m. 30 ſec.

Thirdly, *Sailing Eaſterly*.

The firſt Altitude, Forenoon ——— 10h. 30m.
The ſecond Alt. Afternoon 2h. 36m. 14h. 36m.

Subtract ——————————— 04h. 06m.
Diff. Long. made is 15m. E. or equal to 00h. 01m.

Add, gives the elapſed Time——— 04h. 07m.

Half the elapſed Time ———— 02h. 03m. 30 ſec.

Laſtly, It muſt be obſerved, that the Altitudes taken ſo near together, as within three quarters of an Hour, are liable to a ſmall Error, particularly between nine and ten o'Clock, but between ten and eleven it will be exact enough, provided you take full three quarters of an Hour between them.

Again, the Altitudes taken, one in the Forenoon, and the other in the Afternoon, muſt not exceed five Hours, unleſs Neceſſity requires it, and then above ſix it cannot be taken; yet at five, or a little after, it may be more depended upon than the Latitude by Account.

A TABLE *ſhewing the Depreſſion, or Dip of the viſible Horizon, below the true Horizontal Plane; according to ſeveral Heights (therein mentioned) of the Obſerver's Eye above the Surface of the Sea; to be ſubtracted from the Altitude found by the Inſtrument, and added to the Zenith Diſtance.*

The Eye above the Surface of the Sea *in Feet*	Viſible Horizon depreſs'd in *Minutes.*
1	1
3	2
7	3
12	4
18	5
27	6
35	6½
40	7
45	7½
50	8

Mr. *FLAMSTEED's Table of Refraction, to be ſubtracted from the* Altitude, *and added to the* Zenith Diſtance, *found by the Inſtrument.*

Deg. App. Alt.	Re-fraction		Deg. App. Alt.	Re-fraction		Deg. App. Alt.	Re-fraction		Deg. App. Alt.	Re-fraction	
deg.	m.	ſ.	deg.	m.	ſ.	deg.	m.	ſ.	deg.	m	ſ.
0	33	00	12	3	45	29	1	27	46	0	46
½	26	38	13	3	29	30	1	23	47	0	45
1	23	22	14	3	13	31	1	20	48	0	44
1½	20	17	15	3	00	32	1	17	49	0	42
2	17	26	16	2	48	33	1	14	50	0	40
2½	15	15	17	2	38	34	1	11	51	0	39
3	13	23	18	2	29	35	1	09	52	0	38
3½	11	53	19	2	21	36	1	07	53	0	37
4	10	39	20	2	14	37	1	05	54	0	36
4½	9	38	21	2	07	38	1	02	55	0	34
5	8	48	22	2	01	39	1	00	60	0	29
6	7	26	23	1	55	40	0	58	65	0	24
7	6	25	24	1	50	41	0	56	70	0	19
8	5	37	25	1	45	42	0	54	75	0	14
9	5	02	26	1	40	43	0	52	80	0	09
10	4	33	27	1	36	44	0	50	85	0	04
11	4	06	28	1	31	45	0	48	90	0	00

The Application of the foregoing Inſtructions to Practice.

GENERAL RULE.

Firſt, TO the *Secant leſs Radius* of the Latitude by Account, add the *Secant leſs Radius* of the Sun's Declination, that Sum is the *Logarithm of the Ratio*.

Secondly, Subtract the Hours and Minutes of Time when each Altitude was taken from each other, and half that Remainder is called the *Half Difference of elapſed Time*.

Thirdly, Take the Natural Sines of both Altitudes; ſubtract the leſs from the greater, that Difference call the *Remainder*.

Fourthly, Take the *Logarithm Ratio*, and the common Logarithm of the *Remainder*; alſo the Logarithm of *Half the elapſed Time* anſwerable to the Hours, Minutes, and Seconds in the following new Tables; theſe three added into one Sum, give the *Logarithm of the Middle Time*.

Fifthly, The Hours, Minutes and Seconds anſwering to this *Logarithm of Middle Time* being found in theſe new Tables, ſubtract the ſame from the *Half elapſed Time*, the Remainder is the Time in Hours, Minutes and Seconds, that the Sun had to aſcend to the Meridian when the greateſt Altitude was taken; then enter theſe new Tables with this under the Title of *Riſing*, and from the Logarithm thereto correſponding, ſubtract the *Logarithm of the Ratio*, the Remainder is a common Logarithm, with which enter the common Table of Logarithms, and the Number anſwering thereunto, due Regard being had to the Index, is the Natural Sine of that Degree, Minute, &c. which was wanting of the Sun's Meridional Altitude, when the greateſt Altitude was taken.

Sixthly, To the Natural Sine of the Sun's greateſt Altitude taken, add the Natural Sine laſt found, their Sum is the Natural Sine of the Degree and Minute of the Sun's Meridional Altitude that Day, and at that Place where the greateſt Altitude was taken, which are eaſily diſcovered by obſerving the ſecond Rule in the former Directions concerning Natural Sines, if a Table of Natural Sines are not at Hand: And having obtained the Meridional Altitude, the Latitude is found by the uſual Rules.

Laſtly, Take the Hours, Minutes and Seconds of the *Middle Time*, and alſo of *Half the elapſed Time*, ſubtract the leſs from the greater; this Difference is the true Time from twelve o'Clock, or the Sun's paſſing over the Meridian, when the greateſt Altitude was taken; compare this with the apparent Time by the Watch or Glaſs, and if they agree, your Watch goes true, if not, the Difference ſhews how much too faſt or too ſlow.

For farther Illuſtration, the following Examples are exhibited and performed at large.

EXAMPLE I.

AUGUST the 23d, 1758. Sun's Declination 11d. 17m. North, and at 10h. 02m. in the Forenoon Sun's Altitude was 46d. 55m. then again at 11h. 27m. the ſecond Altitude was 54d. 07m. Latitude by Account is 46d. 50m. North, required the true Latitude, and true Time of the Day, when the greateſt Altitude was taken?

	h.	m.	ſ.		
At —	11	27	00	Lat. by Account, its Sec. leſs Rad.	0.16486
At —	10	02	00	Sun's Declin. its Secant leſs Rad.	0.00847
Half—	01	25	00	Added gives the Logarithm Ratio	0.17333
	00	42	30		
Half elapſed Time					

The Sun's gr. Alt. at 11h. 27m. is 54d. 07m. Nat. Sine 81020
The Sun's Alt. taken at 10h. 02m. is 46d. 55m. Nat. Sine 73030

Subtract———————————— the Remainder 7990

The

The Logarithm of Ratio	0.17333
Common Logarithm of the Remainder	3.90255
New Table of Log. of half elapſed Time for 42m. 30ſ.	0.73429
The Sum is the Logarithm of Middle Time	4.81017

	h.	m.	ſ.
The Hour and Min. *&c.* for which by the New Table is	1	15	30
Subtract from it half elapſed Time	0	42	30
Their Difference is the true Space of Time the Sun had to riſe to the Mer. when the gr. Alt. was taken	0	33	00

By the Watch at	11h.	27m.
Subtract from	12h.	00m.
Remains	00h.	33m.

So I find they agree, and the Watch muſt be exactly right.

	Log. of Riſing
Laſtly, Enter the New Table with 33m. under Riſing	3.01488
Ratio ſubtract from it	0.17333
Remains a Common Log. whoſe Natural Sine ſhews the deg. and min. which were wanting of the Sun's Mer. Alt. when the greateſt Alt. was taken	2.84155

To the Natural Sine of the greateſt Altitude	81020
Add the Natural Sine of the above Logarithm	694
Sum is the Natural Sine	81714

Whoſe Artifical Sine is the deg. and min. of the Sun's Meridian Altitude required.

	d.	m.	
The Deg. *&c.* correſponding are	54	48	
Subtract from	90	00	
The Sun's Zenith Diſtance	35	12 S	
Sun's Declination add	11	17 N	
Lat. at 11h. 27m. in the Foren.	46	29 N	

That Day at Noon it was by Obſer. found to be 46d. 30m. N.

EXAMPLE II.

The Sun's Declination 11d. 17m. North, and at 10h. 26m. in the Forenoon, the firſt Altitude 49d. 13m. the ſecond Altitude in the Afternoon 41d. 13m. at 43 minutes paſt two, at which Time I had made 30m. Difference of Longitude, ſailing to the Weſtward, I demand the Latitude when the greateſt Altitude was taken, and the true Hour of the Day ?

Suppoſed Latitude 46d. 50m. N. Secant leſs Radius —0.16486
Sun's Declination 11d. 17m. N. Secant leſs Radius —0.00847

Logarithm of Ratio —— 0.17333

Forenoon Altitude 49d. 13m. its Natural Sine —— 75720
Afternoon Altitude 41d. 13m. its Natural Sine —— 65890

The Remainder —— 9830

	h.	m.	ſ.		
Afternoon ——	14	43	00	Logarithm Ratio ——	0.17333
Forenoon ——	10	26	00	Common Logarithm Rem.	3.99255
				Log. of half elapſed Time	0.27731
	04	17	00		
For 30 Miles Diff. Longit.	00	02	00	Log. of middle Time ——	4.44319
				Equal to 00h. 32m. 00ſ. as by the New Tables.	
	04	15	00		
½ elapſed Time	02	07	30		
Subtract ——	00	32	00		
Remains ——	01	35	30	The Sun's Diſtance from Meridian when greateſt Alt. was taken.	
Time by the Watch from 12 Hours.	01	34	00	Log. of 1h. 35m 30ſ. called Riſing ——	3.93232
Remains ——	00	01	30	Ratio from it ——	0.17333
Watch too faſt 1 ½ m.				A common Logarithm —	3.75899

Whoſe Natural Sine is 5741 — add to gr. Alt. Nat. Sine 75720
5741

Their Sum is —— 81461

The Artifical Sine of 81461 is 54d. 33m.
From ———————— 90d. 00m.

Sun's Zenith Diſtance ——— 35d. 27 S.
Sun's Declination———— 11d. 17 N.

Lat. at 10h. 26m. in the Foren. 46d. 44N.

EXAMPLE III.

Sailing to the Eaſtward, the Sun's Declination 3d. 38m. N. the firſt Altitude Forenoon 46d. 02m. the ſecond Altitude Afternoon 35d. 43m. Difference of Longitude made is 15 Miles E. the greateſt Altitude at 10h. 30m. the leſſer Altitude at 36m. paſt two in the Afternoon; required the true Time of the Day, and Latitude of the Place at the greateſt Altitude.

Latitude by Account 43d. 30m. N. Secant leſs Radius 0.13943
Sun's Declination — 03d. 38m. N. Secant leſs Radius 0.00087

Logarithm of Ratio ———————————— 0.14030

Forenoon Altitude 46d. 02m. Natural Sine ——— 71970
Afternoon Altitude 35d. 43m. Natural Sine ——— 58370

The Remainder ———————————— 13600

	h.	m.	ſ.
Afternoon——	14	36	00
Forenoon ——	10	30	00
	04	06	00
Diff. Longit. 15 Miles add 1 min	00	01	00
	04	07	00
½ elapſed Time	02	03	30
Subtract ——	00	42	00
True Time—	01	21	30
Sun had to riſe by the Watch	01	30	00
Difference —	00	08	30

Logarithm Ratio ———0.14030
Common Log. Remainder 4.13353
Half elapſed Time ———0.28974

Log. of Middle Time ——4.56357
Equal to — 00h. 42m. 00ſ.

Log. of 1h. 21m. 30ſ. riſing 3.79634
Ratio from it ————0.14030

Common Logarithm —— 3.65604

Watch too ſlow 8 ½ minute.

The Natural Sine of the greateſt Altitude —— 71970
The Natural Sine of the Common Log. 3.65604 is—— 4529

Their Sum—— 76499

The Artifi. Sine of 76499 or Nat. Sine 7650— 49d. 54m.
From—— 90d. 00m.

Sun's Zenith Diſtance—— 40d. 06m. S.
Sun's Declination add—— 03d. 38m. N.

Lat. at half paſt 10 in the Forenoon —— 43d. 44m. N.
Or by true Time at 38 ½ Minutes after ten o'Clock.

To prove this laſt Example by Aſtronomy, in finding the true Time of the Day, we have given the Altitude at 10h. 30m. by the Watch, or 10h. 38m. 30ſ. true Time, equal to 46d. 02m. and the Latitude found to be 43d. 44m. and the Sun's Declination 3d. 38m. to find the true Time.

EXAMPLE.

	d.	m		
Comp. Lat. —	46	16	Comp. Lat. Co. Ar. —	0.141123
Comp. Alt. —	43	58	Comp. Dec. Co. Ar. —	0.000874
Comp. Declin. -	86	22	Sine of half Sum ——	9.999809
Sum	176	36	Sine of the Remainder —	9.844372
½ Sum fr. which ſub. Co. Alt.	88	18	Sum	19.986178
Remainder ——	44	20	Half Sum	9.993089

d. m.
Equal to—— 79 48

Doubled —— 159 36
Subtract from — 180 00

Remains—— 20 24
h. m. ſ.
Equal to 1 21 36
from Noon nearly.

By former Example the true Time from Noon is 1h. 21m. 30ſ. differing only ſix Seconds.

Having from theſe Operations obtained not only the true Latitude, but alſo the true Time of the Day; the true Azimuth is eaſily determined, having oppoſite Sides and Angles given; and as a tolerable Watch cannot be ſuppoſed to vary in the Space of one, two, or three hours, the ſame being duly rectified and adjuſted, as before laid down, the Azimuth may be taken at any reaſonable Time afterwards, and the Variation of the Compaſs aſcertained in a very eaſy and familiar Manner, without the true Latitude, as here follows by

EXAMPLE.

In the Latitude of 51d. 30m. North, the Sun's Declination 15d. 10m. North, at two Minutes paſt ſix in the Afternoon, the Sun's Altitude was 11d. 30m. the Sun's true Azimuth is required at that Time?

The PROPORTION.

d. m.
As the Co. Sine of the Sun's Alt. —— 78 30—9.991193
h. m.
Is to the Sine of the hour from Noon 6 02 = 90 30—9.999983
So is the Co. Sine of the Sun's Declination 74 50—9.984603

19.984586

To the Sine of the Sun's Azimuth = 80 02—9.993393

From North in North Latitude, and from South in South Latitude.

The PROOF of the firſt EXAMPLE by ASTRONOMY.

WE have here given the greateſt Altitude 54d. 07m. taken at 11h. 27m. by the Watch, which happens to be true Time, as appears by the Operation, and the Sun's Declination 11d. 17m. North; to find the Sun's Azimuth and Latitude at 27 min. paſt eleven o'Clock.

OPERATION.

d. m.
As the Sine of the Co. Altitude—————35 53—9·76799

Is to the S. of 33m. the Time from Noon, = 08 15—9.15683
So is the S. Co. Dec. or Sun's Diſt. fr. the Pole 78 43—9.99152

19.14835

d. m.
To the Sine of the Sun's Azimuth from S. 13 53 — 9.38036
Subtract from ——————————180 00

Remains Sun's Azimuth from the North = 166 07

Again,
As the Sine of half the Diff. of the Azimuth, and Hour from Noon 78d. 56m. ——————} 9·99184

Is to S. half their Sum 87d. 11m. ——————— 9 99947
So is the Tangent of half the Diff. of Co. Altit. and Co. Declination 21d. 25m. ——————} 9·59354

19.59301

d. m. ſ.
To the Tang. of half the Co. Lat. = 21 45 30—9.60117
21 45 30

Co. Latitude——————————43 31 00
Subtract from——————————90 00 00

Latitude is——————————46 29 00 N.

Exactly the ſame as in the firſt Example.

The PROOF of the Second EXAMPLE.

We have in the ſecond Example the greateſt Altitude in the Forenoon 49d. 13m. and true Time, found by the Work, from Noon equal to 1h. 35m. 30ſ. equal to 23d. 52m. and Declination 11d. 17m N.

As the Sine of the Co. Altitude 40d. 47m. ——— 9.81504

Is to the Sine of the Hour from Noon 23d. 52m ——— 9.60703
So is the Sine of the Sun's Diſtance from the Pole 78d. 43m. ——— 9.99152

d. m. — 19.59855
180 00

To the Sine of the Sun's Azimuth from S. 37 24 ——— 9.78351

Azimuth from the North ——— 142 36

Again,

As the Sine of half the Diff. of the Azimuth, and Hour from Noon 59d. 22m. ——— 9.93472

Is to S. half their Sum 83d. 14m. ——— 9.99696
So is the Tang. of half Diff. of Co. Altitude and Co. Declination 18d. 58m. ——— 9.53615

19.53311

d. m.
To the Tang. of half the Co. Lat. ——— 21 38 ——— 9.59839
21 38

Co. Latitude ——— 43 16
Subtract from ——— 90 00

Latitude is ——— 46 44 N.

The ſame as in the ſecond Example.

The PROOF of the Third EXAMPLE.

The greateſt Altitude in the Forenoon 46d. 02m. the true Hour from Noon found to be 1 h. 21 m. 30ſ. equal to 20d. 22m. Sun's Declination 3d. 38m. Northerly.

As

As the Sine of the Co. Altitude	43d. 58m.	9.84151
Is to the Sine of the Hour from Noon	20d. 22m.	9.54161
So is the Sine of the Co. Declination	86d. 22m.	9.99912
	d. m.	19.54073
	180 00	
To the Sine of the Sun's true Az. from S.	30 01	9.69922
Sun's true Azimuth from the North	149 59	

Again,

As the Sine of half the Diff. of the Azimuth, and Hour from Noon 64d. 48m.		9.95656
Is to S. half their Sum 85d. 10m.		9.99845
So is the Tang. of half Diff. of Co. Alt. and Co. Declination 21d. 12m.		9.58869
		19.58714
	d. m. ſ.	
To the Tang. of half the Co. Lat.	23 07 48	9.63058
	23 07 48	
Co. Latitude	46 15 36	
Subtract from	90 00 00	
Latitude	43 44 24 N.	
Latitude by the third Example	43 44 00 N.	

The Difference only Twenty-four Seconds.

The

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
0	0	30	2.66121	2.63982	9 37654 } Co. ar	0	20	30	1.04901	4.25202	2.60182
0	1	00	2.36018	2.94085	9.97860 }	0	21	00	1.03857	4.26246	2.62274
0	1	30	2.18409	3.11694	0.33078	0	21	30	1.02838	4.27265	2.64316
0	2	00	2.05916	3.24187	0.58066	0	22	00	1.01843	4.28260	2.66312
0	2	30	1.96225	3.33878	0.77445	0	22	30	1.00870	4.29233	2.68262
0	3	00	1.88307	3.41796	0.93284	0	23	00	0.99918	4.30185	2.70170
0	3	30	1.81613	3.48490	1.06673	0	23	30	0.98988	4.31115	2.72036
0	4	00	1.75814	3.54289	1.18271	0	24	00	0.98077	4.32026	2.73863
0	4	30	1.70700	3.59403	1.28502	0	24	30	0.97184	4.32919	2.75652
0	5	00	1.66125	3.63978	1.37653	0	25	00	0.96310	4.33793	2.77405
0	5	30	1.61986	3.68117	1.45931	0	25	30	0.95454	4.34649	2.79124
0	6	00	1.58208	3.71895	1.53488	0	26	00	0.94614	4.35489	2.80809
0	6	30	1.54733	3.75370	1.60440	0	26	30	0.93791	4.363[illegible]3	2.82461
0	7	00	1.51515	3.78588	1.66877	0	27	00	0.92982	4.371[illegible]1	2.84083
0	7	30	1.48520	3.81583	1.72869	0	27	30	0.92189	4.379[illegible]4	2.85675
0	8	00	1.45718	3.84385	1.78474	0	28	00	0.91411	4.38[illegible]92	2.872[illegible]8
0	8	30	1.43086	3.87017	1.83739	0	28	30	0.90646	4.39457	2.88773
0	9	00	1.40605	3.89498	1.88703	0	29	00	0.89894	4.40209	2.90282
0	9	30	1.38258	3.91845	.93399	0	29	30	0.89156	4.40947	2.91765
0	10	00	1.36032	3.94071	1.97854	0	30	00	0.88430	4.41673	2.93223
0	10	30	1.33915	3.96188	2.02091	0	30	30	0.87717	4.42386	2.94656
0	11	00	1.31896	3.98207	2.06131	0	31	00	0.87015	4.43088	2.96067
0	11	30	1.29967	4.00136	2.09991	0	31	30	0.86324	4.43779	2.97454
0	12	00	1.28120	4.01983	2.13687	0	32	00	0.85644	4.44459	2.98820
0	12	30	1.26349	4.03754	2.17232	0	32	30	0.84976	4.45127	3.00164
0	13	00	1.24647	4.05456	2.20638	0	33	00	0.84317	4.45786	3.01488
0	13	30	1.23010	4.07093	2.23915	0	33	30	0.83669	4.46434	3.02792
0	14	00	1.21432	4.08671	2.27073	0	34	00	0.83030	4.47073	3.04077
0	14	30	1.19910	4.10193	2.30120	0	34	30	0.82400	4.47703	3.05342
0	15	00	1.18440	4.11663	2.33063	0	35	00	0.81780	4.48323	3.06590
0	15	30	1.17018	4.13085	2.35910	0	35	30	0.81169	4.48934	3.07819
0	16	00	1.15642	4.14461	2.38667	0	36	00	0.80567	4.49536	3.09032
0	16	30	1.14307	4.15796	2.41338	0	36	30	0.79973	4.50130	3.10227
0	17	00	1.13013	4.17090	2.43930	0	37	00	0.79387	4.50716	3.11406
0	17	30	1.11757	4.18346	2.46447	0	37	30	0.78809	4.51294	3.12570
0	18	00	1.10536	4.19567	2.48893	0	38	00	0.78239	4.51864	3.13718
0	18	30	1.09348	4.20755	2.51271	0	38	30	0.77677	4.52426	3.14850
0	19	00	1.08193	4.21910	2.53586	0	39	00	0.77122	4.52981	3.15969
0	19	30	1.07067	4.23036	2.55841	0	39	30	0.76574	4.53529	3.17072
0	20	00	1.05970	4.24133	2.58039	0	40	00	0.76033	4.54070	3.18162

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
0	40	30	0.75499	4.54604	3.19238	1	00	30	0.58348	4.71755	3.53959
0	41	00	0.74972	4.55131	3.20301	1	01	00	0.57999	4.72104	3.54670
0	41	30	0.74451	4.55652	3.21351	1	01	30	0.57653	4.72450	3.55375
0	42	00	0.73937	4.56166	3.22389	1	02	00	0.57310	4.72793	3.56074
0	42	30	0.73429	4.56674	3.23414	1	02	30	0.56970	4.73133	3.56767
0	43	00	0.72927	4.57176	3.24427	1	03	00	0.56633	4.73470	3.57455
0	43	30	0.72430	4.57673	3.25428	1	03	30	0.56298	4.73805	3.58137
0	44	00	0.71940	4.58163	3.26418	1	04	00	0.55966	4.74137	3.58814
0	44	30	0.71455	4.58648	3.27396	1	04	30	0.55637	4.74466	3.59486
0	45	00	0.70976	4.59127	3.28363	1	05	00	0.55311	4.74792	3.60152
0	45	30	0.70503	4.59600	3.29320	1	05	30	0.54987	4.75116	3.60813
0	46	00	0.70034	4.60069	3.30266	1	06	00	0.54666	4.75437	3.61469
0	46	30	0.69571	4.60532	3.31202	1	06	30	0.54347	4.75756	3.62120
0	47	00	0.69113	4.60990	3.32128	1	07	00	0.54031	4.76072	3.62766
0	47	30	0.68660	4.61443	3.33044	1	07	30	0.53718	4.76385	3.63407
0	48	00	0.68212	4.61891	3.33950	1	08	00	0.53406	4.76697	3.64043
0	48	30	0.67769	4.62334	3.34847	1	08	30	0.53098	4.77005	3.64675
0	49	00	0.67330	4.62773	3.35734	1	09	00	0.52791	4.77312	3.65302
0	49	30	0.66896	4.63207	3.36613	1	09	30	0.52487	4.77616	3.65924
0	50	00	0.66466	4.63637	3.37482	1	10	00	0.52186	4.77917	3.66542
0	50	30	0.66041	4.64062	3.38343	1	10	30	0.51886	4.78217	3.67156
0	51	00	0.65620	4.64483	3.39195	1	11	00	0.51589	4.78514	3.67765
0	51	30	0.65204	4.64899	3.40039	1	11	30	0.51294	4.78809	3.68369
0	52	00	0.64791	4.65312	3.40875	1	12	00	0.51002	4.79101	3.68969
0	52	30	0.64383	4.65720	3.41702	1	12	30	0.50711	4.79392	3.69566
0	53	00	0.63978	4.66125	3.42522	1	13	00	0.50423	4.79680	3.70158
0	53	30	0.63578	4.66525	3.43334	1	13	30	0.50137	4.79966	3.70745
0	54	00	0.63181	4.66922	3.44138	1	14	00	0.49852	4.80251	3.71329
0	54	30	0.62789	4.67314	3.44935	1	14	30	0.49570	4.80533	3.71909
0	55	00	0.62400	4.67703	3.45724	1	15	00	0.49290	4.80813	3.72485
0	55	30	0.62014	4.68089	3.46507	1	15	30	0.49012	4.81091	3.73057
0	56	00	0.61632	4.68471	3.47282	1	16	00	0.48736	4.81367	3.73625
0	56	30	0.61254	4.68849	3.48050	1	16	30	0.48462	4.81641	3.74189
0	57	00	0.60879	4.69224	3.48811	1	17	00	0.48189	4.81914	3.74750
0	57	30	0.60508	4.69595	3.49566	1	17	30	0.47919	4.82184	3.75307
0	58	00	0.60140	4.69963	3.50314	1	18	00	0.47650	4.82453	3.75860
0	58	30	0.59775	4.70328	3.51056	1	18	30	0.47384	4.82719	3.76409
0	59	00	0.59414	4.70689	3.51791	1	19	00	0.47119	4.82984	3.76955
0	59	30	0.59056	4.71047	3.52520	1	19	30	0.46856	4.83247	3.77498
1	00	00	0.58700	4.71403	3.53243	1	20	00	0.46595	4.83508	3.78037

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
1	20	30	0.46335	4.83768	3.78573	1	40	30	0.37203	4.92900	3.97597
1	21	00	0.46078	4.84025	3.79105	1	41	00	0.37001	4.93102	3.98021
1	21	30	0.45822	4.84281	3.79634	1	41	30	0.36801	4.93302	3.98443
1	22	00	0.45567	4.84536	3.80159	1	42	00	0.36602	4.93501	3.98862
1	22	30	0.45315	4.84788	3.80682	1	42	30	0.36403	4.93700	3.99280
1	23	00	0.45064	4.85039	3.81201	1	43	00	0.36206	4.93897	3.99696
1	23	30	0.44815	4.85288	3.81717	1	43	30	0.36011	4.94092	4.00109
1	24	00	0.44567	4.85536	3.82230	1	44	00	0.35816	4.94287	4.00521
1	24	30	0.44321	4.85782	3.82739	1	44	30	0.35622	4.94481	4.00930
1	25	00	0.44077	4.86026	3.83246	1	45	00	0.35429	4.94674	4.01337
1	25	30	0.43834	4.86269	3.83749	1	45	30	0.35238	4.94865	4.01743
1	26	00	0.43592	4.86511	3.84250	1	46	00	0.35047	4.95056	4.02146
1	26	30	0.43353	4.86750	3.84748	1	46	30	0.34858	4.95245	4.02547
1	27	00	0.43114	4.86989	3.85242	1	47	00	0.34669	4.95434	4.02947
1	27	30	0.42878	4.87225	3.85734	1	47	30	0.34482	4.95621	4.03344
1	28	00	0.42642	4.87461	3.86223	1	48	00	0.34295	4.95808	4.03740
1	28	30	0.42409	4.87694	3.86709	1	48	30	0.34110	4.95993	4.04134
1	29	00	0.42176	4.87927	3.87192	1	49	00	0.33925	4.96178	4.04526
1	29	30	0.41945	4.88158	3.87672	1	49	30	0.33742	4.96361	4.04916
1	30	00	0.41716	4.88387	3.88150	1	50	00	0.33559	4.96544	4.05304
1	30	30	0.41488	4.88615	3.88625	1	50	30	0.33378	4.96725	4.05690
1	31	00	0.41261	4.88842	3.89097	1	51	00	0.33197	4.96906	4.06074
1	31	30	0.41036	4.89067	3.89567	1	51	30	0.33018	4.97085	4.06457
1	32	00	0.40812	4.89291	3.90034	1	52	00	0.32839	4.97264	4.06838
1	32	30	0.40590	4.89513	3.90498	1	52	30	0.32661	4.97442	4.07217
1	33	00	0.40368	4.89734	3.90960	1	53	00	0.32485	4.97618	4.07595
1	33	30	0.40149	4.89954	3.91420	1	53	30	0.32309	4.97794	4.07970
1	34	00	0.39930	4.90173	3.91876	1	54	00	0.32134	4.97969	4.08344
1	34	30	0.39713	4.90390	3.92331	1	54	30	0.31960	4.98143	4.08716
1	35	00	0.39497	4.90606	3.92782	1	55	00	0.31787	4.98316	4.09087
1	35	30	0.39282	4.90821	3.93232	1	55	30	0.31614	4.98489	4.09456
1	36	00	0.39069	4.91034	3.93679	1	56	00	0.31443	4.98660	4.09823
1	36	30	0.38856	4.91247	3.94123	1	56	30	0.31272	4.98831	4.10188
1	37	00	0.38646	4.91457	3.94566	1	57	00	0.31103	4.99000	4.10552
1	37	30	0.38436	4.91667	3.95005	1	57	30	0.30934	4.99169	4.10914
1	38	00	0.38227	4.91876	3.95443	1	58	00	0.30766	4.99337	4.11275
1	38	30	0.38020	4.92083	3.95878	1	58	30	0.30599	4.99504	4.11634
1	39	00	0.37814	4.92289	3.96311	1	59	00	0.30433	4.99670	4.11992
1	39	30	0.37609	4.92494	3.96742	1	59	30	0.30268	4.99835	4.12348
1	40	00	0.37405	4.92698	3.97170	2	00	00	0.30103	5.00000	4.12702

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
2	00	30	0.29939	5·00164	4·13055	2	20	30	0.24006	5·06097	4·26031
2	01	00	0.29776	5·00327	4·13406	2	21	00	0.23871	5·06232	4·26330
2	01	30	0.29614	5·00489	4·13756	2	21	30	0.23738	5·06365	4·26628
2	02	00	0.29453	5·00650	4·14104	2	22	00	0.23605	5·06498	4·26924
2	02	30	0.29293	5·00810	4·14451	2	22	30	0.23472	5·06631	4·27220
2	03	00	0.29133	5·00970	4·14797	2	23	00	0.23340	5·06763	4·27514
2	03	30	0.28974	5·01129	4·15140	2	23	30	0.23209	5·06894	4·27807
2	04	00	0.28816	5·01287	4·15483	2	24	00	0.23078	5·07025	4·28099
2	04	30	0.28659	5·01444	4·15824	2	24	30	0.22948	5·07155	4·28391
2	05	00	0.28502	5·01601	4·16163	2	25	00	0.22819	5·07284	4·28681
2	05	30	0.28346	5·01757	4·16501	2	25	30	0.22690	5·07413	4·28969
2	06	00	0.28191	5·01912	4·16838	2	26	00	0.22561	5·07542	4·29257
2	06	30	0.28037	5·02066	4·17173	2	26	30	0.22433	5·07670	4·29544
2	07	00	0.27884	5·02219	4·17507	2	27	00	0.22306	5·07797	4·29830
2	07	30	0.27731	5·02372	4·17839	2	27	30	0.22180	5·07923	4·30115
2	08	00	0.27579	5·02524	4·18171	2	28	00	0.22054	5·08049	4·30398
2	08	30	0.27428	5·02675	4·18500	2	28	30	0.21928	5·08175	4·30681
2	09	00	0.27277	5·02826	4·18829	2	29	00	0.21803	5·08300	4·30963
2	09	30	0.27127	5·02976	4·19156	2	29	30	0.21679	5·08424	4·31244
2	10	00	0.26978	5·03125	4·19482	2	30	00	0.21555	5·08548	4·31523
2	10	30	0.26830	5·03273	4·19806	2	30	30	0.21432	5·08671	4·31801
2	11	00	0.26682	5·03421	4·20129	2	31	00	0.21309	5·08794	4·32079
2	11	30	0.26535	5·03568	4·20451	2	31	30	0.21187	5·08916	4·32355
2	12	00	0.26389	5·03714	4·20771	2	32	00	0.21066	5·09037	4·32631
2	12	30	0.26244	5·03859	4·21091	2	32	30	0.20945	5·09158	4·32906
2	13	00	0.26099	5·04004	4·21409	2	33	00	0.20824	5·09279	4·33180
2	13	30	0.25955	5·04148	4·21725	2	33	30	0.20704	5·09399	4·33452
2	14	00	0.25811	3·04292	4·22041	2	34	00	0.20585	5·09518	4·33724
2	14	30	0.25668	5·04435	4·22355	2	34	30	0.20466	5·09637	4·33995
2	15	00	0.25526	5·04577	4·22668	2	35	00	0.20348	5·09755	4·34265
2	15	30	0.25385	5·04718	4·22980	2	35	30	0.20230	5·09873	4·34534
2	16	00	0.25244	3·04859	4·23290	2	36	00	0.20113	5·09990	4·34802
2	16	30	0.25104	5·04999	4·23599	2	36	30	0.19996	5·10107	4·35069
2	17	00	0.24964	5·05139	4·23907	2	37	00	0.19880	5·10223	4·35335
2	17	30	0.24825	5·05278	4·24214	2	37	30	0.19764	5·10339	4·35600
2	18	00	0.24687	5·05416	4·24520	2	38	00	0.19648	5·10454	4·35865
2	18	30	0.24550	5·05553	4·24825	2	38	30	0.19534	5·10569	4·36128
2	19	00	0.24413	5·05690	4·25128	2	39	00	0.19420	5·10683	4·36391
2	19	30	0.24277	5·05826	4·25430	2	39	30	0.19306	5·10797	4·36652
2	20	00	0.24141	5·05962	4·25731	2	40	00	0.19193	5·10910	4·36913

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
2	40	30	0.19080	5.11023	4.37173	3	00	30	0.14957	5.15146	4.46899
2	41	00	0.18968	5.11135	4.37432	3	01	00	0.14863	5.15240	4.47127
2	41	30	0.18857	5.11246	4.37690	3	01	30	0.14769	5.15334	4.47354
2	42	00	0.18746	5.11357	4.37948	3	02	00	0.14676	5.15427	4.47580
2	42	30	0.18635	5.11468	4.38204	3	02	30	0.14583	5.15520	4.47806
2	43	00	0.18525	5.11578	4.38460	3	03	00	0.14490	5.15613	4.48031
2	43	30	0.18415	5.11688	4.38714	3	03	30	0.14398	5.15705	4.48255
2	44	00	0.18306	5.11797	4.38968	3	04	00	0.14306	5.15797	4.48479
2	44	30	0.18197	5.11906	4.39221	3	04	30	0.14215	5.15888	4.48702
2	45	00	0.18089	5.12014	4.39473	3	05	00	0.14124	5.15979	4.48924
2	45	30	0.17981	5.12122	4.39724	3	05	30	0.14034	5.16069	4.49145
2	46	00	0.17874	5.12229	4.39975	3	06	00	0.13944	5.16159	4.49366
2	46	30	0.17767	5.12336	4.40225	3	06	30	0.13854	5.16249	4.49586
2	47	00	0.17660	5.12443	4.40474	3	07	00	0.13765	5.16338	4.49806
2	47	30	0.17554	5.12549	4.40722	3	07	30	0.13676	5.16427	4.50025
2	48	00	0.17449	5.12654	4.40969	3	08	00	0.13587	5.16516	4.50243
2	48	30	0.17344	5.12759	4.41215	3	08	30	0.13499	5.16604	4.50460
2	49	00	0.17239	5.12864	4.41461	3	09	00	0.13411	5.16692	4.50677
2	49	30	0.17135	5.12968	4.41706	3	09	30	0.13324	5.16779	4.50893
2	50	00	0.17031	5.13071	4.41950	3	10	00	0.13237	5.16866	4.51109
2	50	30	0.16928	5.13174	4.42193	3	10	30	0.13150	5.16953	4.51324
2	51	00	0.16826	5.13277	4.42435	3	11	00	0.13064	5.17039	4.51539
2	51	30	0.16724	5.13379	4.42677	3	11	30	0.12978	5.17125	4.51753
2	52	00	0.16622	5.13481	4.42918	3	12	00	0.12893	5.17210	4.51966
2	52	30	0.16520	5.13583	4.43158	3	12	30	0.12808	5.17295	4.52178
2	53	00	0.16419	5.13684	4.43398	3	13	00	0.12723	5.17380	4.52390
2	53	30	0.16319	5.13784	4.43636	3	13	30	0.12638	5.17465	4.52601
2	54	00	0.16219	5.13884	4.43874	3	14	00	0.12554	5.17549	4.52812
2	54	30	0.16119	5.13984	4.44111	3	14	30	0.12470	5.17633	4.53022
2	55	00	0.16020	5.14083	4.44348	3	15	00	0.12387	5.17716	4.53231
2	55	30	0.15921	5.14182	4.44583	3	15	30	0.12304	5.17799	4.53440
2	56	00	0.15823	5.14280	4.44818	3	16	00	0.12222	5.17881	4.53648
2	56	30	0.15725	5.14378	4.45052	3	16	30	0.12140	5.17963	4.53856
2	57	00	0.15627	5.14476	4.45286	3	17	00	0.12058	5.18045	4.54063
2	57	30	0.15530	5.14573	4.45518	3	17	30	0.11977	5.18126	4.54269
2	58	00	0.15434	5.14669	4.45750	3	18	00	0.11896	5.18207	4.54475
2	58	30	0.15338	5.14765	4.45981	3	18	30	0.11815	5.18288	4.54680
2	59	00	0.15242	5.14861	4.46212	3	19	00	0.11734	5.18369	4.54885
2	59	30	0.15146	5.14957	4.46442	3	19	30	0.11654	5.18449	4.55089
3	00	00	0.15051	5.15052	4.46671	3	20	00	0.11574	5.18529	4.55293

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
3	20	30	0.11495	5.18608	4.55496
3	21	00	0.11416	5.18687	4.55698
3	21	30	0.11337	5.18766	4.55900
3	22	00	0.11259	5.18844	4.56101
3	22	30	0.11181	5.18922	4.56301
3	23	00	0.11104	5.18999	4.56501
3	23	30	0.11027	5.19076	4.56701
3	24	00	0.10950	5.19153	4.56900
3	24	30	0.10873	5.19230	4.57098
3	25	00	0.10797	5.19306	4.57296
3	25	30	0.10721	5.19382	4.57494
3	26	00	0.10645	5.19458	4.57690
3	26	30	0.10570	5.19533	4.57886
3	27	00	0.10495	5.19608	4.58082
3	27	30	0.10421	5.19682	4.58277
3	28	00	0.10347	5.19756	4.58471
3	28	30	0.10273	5.19830	4.58665
3	29	00	0.10199	5.19904	4.58859
3	29	30	0.10126	5.19977	4.59052
3	30	00	0.10053	5.20050	4.59244
3	30	30	0.09981	5.20122	4.59436
3	31	00	0.09909	5.20194	4.59627
3	31	30	0.09837	5.20266	4.59818
3	32	00	0.09765	5.20338	4.60008
3	32	30	0.09694	5.20409	4.60198
3	33	00	0.09623	5.20480	4.60388
3	33	30	0.09552	5.20551	4.60577
3	34	00	0.09482	5.20621	4.60765
3	34	30	0.09412	5 20691	4.60952
3	35	00	0.09342	5.20761	4.61139
3	35	30	0.09273	5.20830	4.61326
3	36	00	0.09204	5.20899	4.61512
3	36	30	0.09135	5.20968	4.61698
3	37	00	0.09067	5.21036	4.61883
3	37	30	0.08999	5.21104	4.62068
3	38	00	0.08931	5.21172	4.62252
3	38	30	0.08864	5.21239	4.62436
3	39	00	0.08797	5.21306	4.62619
3	39	30	0.08730	5.21373	4.62802
3	40	00	0.08664	5.21439	4.62984
3	40	30	0.08597	5.21505	4.63166
3	41	00	0.08531	5.21571	4.63347
3	41	30	0.08466	5.21637	4.63528
3	42	00	0.08401	5.21702	4.63708
3	42	30	0,08336	5.21767	4.63888
3	43	00	0.08271	5.21832	4.64067
3	43	30	0.08207	5.21896	4.64246
3	44	00	0.08143	5.21960	4.64425
3	44	30	0.08079	5.22024	4.64603
3	45	00	0.08015	5.22088	4.64780
3	45	30	0.07952	5.22151	4.64957
3	46	00	0.07889	5.22214	4.65134
3	46	30	0.07827	5.22276	4.65310
3	47	00	0.07765	5,22338	4.65486
3	47	30	0.07703	5.22400	4.65661
3	48	00	0.07641	5.22462	4.65836
3	48	30	0.07579	5.22524	4.66010
3	49	00	0.07518	5.22585	4.66184
3	49	30	0.07457	5.22646	4.66357
3	50	00	0.07397	5,22706	4.66530
3	50	30	0.07337	5.22766	4.66702
3	51	00	0.07277	5.22826	4.66874
3	51	30	0.07217	5.22886	4.67046
3	52	00	0.07158	5.22945	4.67217
3	52	30	0.07099	5.23004	4.67388
3	53	00	0.07040	5.23063	4.67558
3	53	30	0.06981	5.23122	4.67728
3	54	00	0.06923	5.23180	4.67897
3	54	30	0.06865	5.23238	4.68066
3	55	00	0.06808	5.23295	4.68235
3	55	30	0.06751	5.23352	4,68403
3	56	00	0.06694	5.23409	4.68571
3	56	30	0.06637	5.23466	4.68738
3	57	00	0.06580	5.23523	4.68905
3	57	30	0.06524	5.23579	4.69071
3	58	00	0.06468	5.23635	4.69237
3	58	30	0.06412	5.23691	4.69403
3	59	00	0.06357	5.23746	4.69568
3	59	30	0.06302	5.23801	4.69733
4	00	00	0.06247	5.23856	4.69897

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
4	00	30	0.06192	5.23911	4.70061	4	20	30	0.04228	5.25875	4.76295
4	01	00	0.06138	5.23965	4.70224	4	21	00	0.04184	5.25919	4.76443
4	01	30	0.06084	5.24019	4.70387	4	21	30	0.04141	5.25962	4.76591
4	02	00	0.06030	5.24073	4.70550	4	22	00	0.04098	5.26005	4.76738
4	02	30	0.05977	5.24126	4.70712	4	22	30	0.04055	5.26048	4.76885
4	03	00	0.05924	5.24179	4.70874	4	23	00	0.04012	5.26091	4.77032
4	03	30	0.05871	5.24232	4.71036	4	23	30	0.03969	5.26134	4.77179
4	04	00	0.05818	5.24285	4.71197	4	24	00	0.03927	5.26176	4.77325
4	04	30	0.05766	5.24337	4.71358	4	24	30	0.03885	5.26218	4.77471
4	05	00	0.05714	5.24389	4.71518	4	25	00	0.03843	5.26260	4.77616
4	05	30	0.05662	5.24441	4.71676	4	25	30	0.03801	5.26302	4.77761
4	06	00	0.05610	5.24493	4.71837	4	26	00	0.03760	5.26343	4.77906
4	06	30	0.05559	5.24544	4.71996	4	26	30	0.03719	5.26384	4.78050
4	07	00	0.05508	5.24595	4.72155	4	27	00	0.03678	5.26425	4.78194
4	07	30	0.05457	5.24646	4.72313	4	27	30	0.03638	5.26466	4.78338
4	08	00	0.05406	5.24697	4.72471	4	28	00	0.03597	5.26506	4.78481
4	08	30	0.05356	5.24747	4.72628	4	28	30	0.03557	5.26546	4.78624
4	09	00	0.05306	5.24797	4.72786	4	29	00	0.03517	5.26586	4.78767
4	09	30	0.05256	5.24847	4.72942	4	29	30	0.03478	5.26626	4.78909
4	10	00	0.05207	5.24896	4.73098	4	30	00	0.03438	5.26665	4.79051
4	10	30	0.05158	5.24945	4.73254	4	30	30	0.03399	5.26704	4.79193
4	11	00	0.05109	5.24994	4.73410	4	31	00	0.03360	5.26743	4.79334
4	11	30	0.05060	5.25043	4.73565	4	31	30	0.03321	5.26782	4.79475
4	12	00	0.05012	5.25091	4.73720	4	32	00	0.03283	5.26820	4.79616
4	12	30	0.04964	5.25139	4.73874	4	32	30	0.03245	5.26858	4.79756
4	13	00	0.04916	5.25187	4.74028	4	33	00	0.03207	5.26896	4.79896
4	13	30	0.04868	5.25235	4.74182	4	33	30	0.03170	5.26934	4.80036
4	14	00	0.04821	5.25282	4.74335	4	34	00	0.03132	5.26971	4.80175
4	14	30	0.04774	5.25329	4.74488	4	34	30	0.03095	5.27008	4.80314
4	15	00	0.04727	5.25376	4.74641	4	35	00	0.03058	5.27045	4.80453
4	15	30	0.04680	5.25423	4.74793	4	35	30	0.03021	5.27082	4.80591
4	16	00	0.04634	5.25469	4.74945	4	36	00	0.02985	5.27118	4.80729
4	16	30	0.04588	5.25515	4.75096	4	36	30	0.02949	5.27154	4.80867
4	17	00	0.04542	5.25561	4.75247	4	37	00	0.02913	5.27190	4.81004
4	17	30	0.04496	5.25607	4.75398	4	37	30	0.02877	5.27226	4.81141
4	18	00	0.04451	5.25652	4.75549	4	38	00	0.02841	5.27262	4.81278
4	18	30	0.04406	5.25697	4.75699	4	38	30	0.02806	5.27297	4.81414
4	19	00	0.04361	5.25742	4.75848	4	39	00	0.02771	5.27332	4.81550
4	19	30	0.04316	5.25787	4.75997	4	39	30	0.02736	5.27367	4.81686
4	20	00	0.04272	5.25831	4.76146	4	40	00	0.02701	5.27402	4.81821

H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
4	40	30	0.02667	5.27436	4.81956	5	00	30	0.01480	5.28623	4.87116
4	41	00	0.02633	5.27470	4.82091	5	01	00	0.01455	5.28648	4.87239
4	41	30	0.02599	5.27504	4.82226	5	01	30	0.01430	5.28673	4.87362
4	42	00	0.02565	5.27538	4.82360	5	02	00	0.01405	5.28698	4.87484
4	42	30	0.02532	5.27571	4.82494	5	02	30	0,01381	5.28722	4.87606
4	43	00	0.02499	5.27604	4.82628	5	03	00	0.01357	5.28746	4.87728
4	43	30	0.02466	5.27637	4.82761	5	03	30	0.01333	5.28770	4.87850
4	44	00	0.02433	5.27670	4.82894	5	04	00	0.01309	5.28794	4.87971
4	44	30	0.02400	5.27703	4.83027	5	04	30	0.01286	5.28817	4.88092
4	45	00	0.02368	5.27735	4.83159	5	05	00	0.01263	5.28840	4.88213
4	45	30	0.02336	5.27767	4.83291	5	05	30	0.01240	5.28863	4,88334
4	46	00	0.02304	5.27799	4.83423	5	06	00	0.01217	5.28886	4.88454
4	46	30	0.02272	5.27831	4.83554	5	06	30	0.01194	5.28909	4.88574
4	47	00	0.02241	5.27862	4.83685	5	07	00	0.01172	5,28931	4.88694
4	47	30	0.02210	5.27893	4.83816	5	07	30	0.01150	5.28953	4.88814
4	48	00	0.02179	5.27924	4.83947	5	08	00	0.01128	5.28975	4.88933
4	48	30	0.02148	5.27955	4.84077	5	08	30	0.01106	5.28997	4.89052
4	49	00	0.02118	5.27985	4.84207	5	09	00	0.01084	5.29019	4.89171
4	49	30	0.02088	5.28015	4.84337	5	09	30	0.01063	5.29040	4.89289
4	50	00	0.02058	5.28045	4.84466	5	10	00	0.01042	5,29061	4.89407
4	50	30	0,02028	5.28075	4.84595	5	10	30	0.01021	5.29082	4.89525
4	51	00	0.01998	5.28105	4.84724	5	11	00	0.01000	5.29103	4.89643
4	51	30	0.01969	5.28134	4.84853	5	11	30	0.00980	5.29123	4.89760
4	52	00	0.01940	5.28163	4.84981	5	12	00	0.00960	5.29143	4.89877
4	52	30	0.01911	5.28192	4.85109	5	12	30	0.00940	5.29163	4.89994
4	53	00	0.01882	5.28221	4.85236	5	13	00	0.00920	5.29183	4.90111
4	53	30	0.01854	5.28249	4.85363	5	13	30	0.00900	5.29203	4.90227
4	54	00	0.01826	5.28277	4.85490	5	14	00	0.00881	5.29222	4.90343
4	54	30	0.01798	5 28305	4.85617	5	14	30	0.00862	5.29241	4.90459
4	55	00	0.01770	5.28333	4.85744	5	15	00	0.00843	5.29260	4.90575
4	55	30	0.01743	5.28360	4.85870	5	15	30	0.00824	5.29279	4.90690
4	56	00	0.01716	5.28387	4.85996	5	16	00	0.00805	5.29298	4.90805
4	56	30	0.01689	5.28414	4.86121	5	16	30	0.00787	5.29316	4.90920
4	57	00	0.01662	5.28441	4.86246	5	17	00	0.00769	5.29334	4.91035
4	57	30	0.01635	5.28468	4.86371	5	17	30	0.00751	5.29352	4.91149
4	58	00	0.01609	5.28494	4.86496	5	18	00	0.00733	5.29370	4.91263
4	58	30	0.01583	5.28520	4.86621	5	18	30	0.00716	5.29387	4,91377
4	59	00	0.01557	5.28546	4.86745	5	19	00	0.00699	5.29404	4.91490
4	59	30	0.01531	5.28572	4.86869	5	19	30	0.00682	5.29421	4.91603
5	00	00	0.01505	5.28598	4.86993	5	20	00	0.00665	5.29438	4.91716

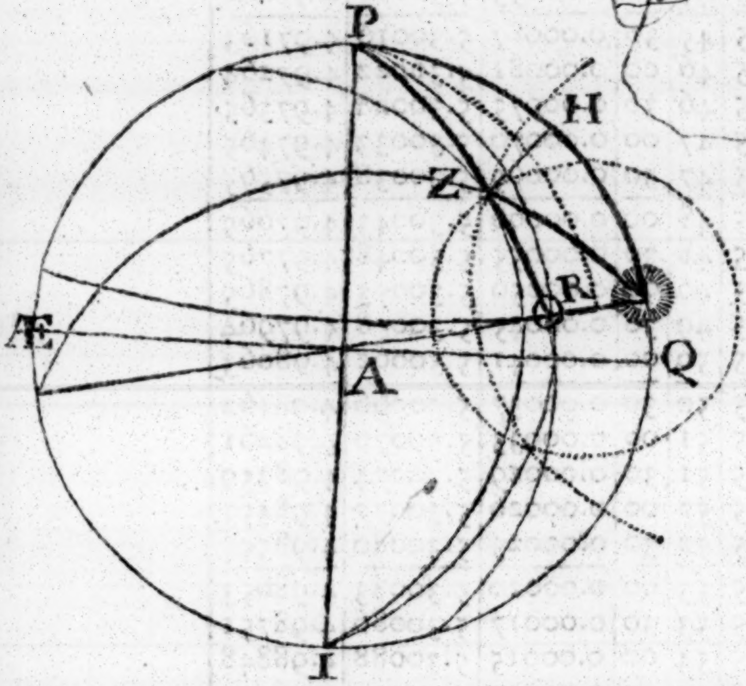
H	M	S	Half Elapſed Time.	Middle Time.	Riſing.	H	M	S	Half Elapſed Time.	Middle Time.	Riſing.
5	20	30	0.00648	5·29455	4·91829	5	40	30	0.00158	5·29945	4·96143
5	21	00	0.00632	5·29471	4·91942	5	41	00	0.00150	5·29953	4·96246
5	21	30	0.00616	5·29487	4·92054	5	41	30	0.00142	5·29961	4·96349
5	22	00	0.00600	5·29503	4·92166	5	42	00	0.00134	5·29969	4·96452
5	22	30	0.00584	5·29519	4 92278	5	42	30	0.00127	5·29976	4·96554
5	23	00	0.00568	5·29535	4·92390	5	43	00	0.00120	5·29983	4·96656
5	23	30	0.00553	5·29550	4·92501	5	43	30	0.00113	5·29990	4·96758
5	24	00	0.00538	5·29565	4·92612	5	44	00	0.00106	5·29997	4·96860
5	24	30	0.00523	5·29580	4·92723	5	44	30	0.00099	5·30004	4·96961
5	25	00	0.00508	5·29595	4·92834	5	45	00	0.00093	5·30010	4·97062
5	25	30	0.00494	5·29609	4·92944	5	45	30	0.00087	5·30016	4·97163
5	26	00	0.00480	5·29623	4·93054	5	46	00	0.00081	5·30022	4·97264
5	26	30	0.00466	5·29637	4·93164	5	46	30	0.00075	5·30028	4·97365
5	27	00	0.00452	5·29651	4·93274	5	47	00	0.00070	5·30033	4·97465
5	27	30	0.00438	5·29665	4·93383	5	47	30	0.00065	5·30038	4·97565
5	28	00	0.00425	5·29678	4·93492	5	48	00	0.00060	5·30043	4·97665
5	28	30	0.00412	5·29691	4·93601	5	48	30	0.00055	5·30048	4·97765
5	29	00	0.00399	5·29704	4·93709	5	49	00	0.00050	5·30053	4·97865
5	29	30	0.00386	5·29717	4·93817	5	49	30	0.00045	5·30058	4·97964
5	30	00	0.00373	5·29730	4·93925	5	50	00	0.00041	5·30062	4·98063
5	30	30	0.00361	5·29742	4·94033	5	50	30	0.00037	5·30066	4·98162
5	31	00	0.00349	5·29754	4·94141	5	51	00	0.00033	5·30070	4·98261
5	31	30	0.00337	5·29766	4·94248	5	51	30	0.00029	5·30074	4·98359
5	32	00	0.00325	5·29778	4·94356	5	52	00	0.00026	5·30077	4·98457
5	32	30	0.00313	5·29790	4·94463	5	52	30	0.00023	5·30080	4·98555
5	33	00	0.00302	5·29801	4·94570	5	53	00	0.00020	5·30083	4·98653
5	33	30	0.00291	5·29812	4·94676	5	53	30	0.00017	5·30086	4·98751
5	34	00	0.00280	5·29823	4·94782	5	54	00	0.00015	5·30088	4·98848
5	34	30	0.00269	5·29834	4·94888	5	54	30	0.00012	5·30090	4·98945
5	35	00	0.00259	5·29844	4·94994	5	55	00	0.00010	5·30092	4·99042
5	35	30	0.00249	5·29854	4·95100	5	55	30	0.00008	5·30094	4·99139
5	36	00	0.00239	5·29864	4·95205	5	56	00	0.00007	5·30096	4·99236
5	36	30	0.00229	5·29874	4·95310	5	56	30	0.00005	5·30098	4·99332
5	37	00	0.00219	5·29884	4·95415	5	57	00	0.00004	5·30099	4·99428
5	37	30	0.00209	5·29894	4·95520	5	57	30	0.00003	5·30100	4·99524
5	38	00	0.00200	5·29903	4·95624	5	58	00	0.00002	5·30101	4·99620
5	38	30	0.00191	5·29912	4·95728	5	58	30	0.00001	5·30102	4·99715
5	39	00	0.00182	5·29921	4·95832	5	59	00	0.00000	5·30103	4·99810
5	39	30	0.00174	5·29929	4·95936	5	59	30	0.00000	5·30103	4·99905
5	40	00	0.00166	5·29937	4·96040	6	00	00	0.00000	5·30103	5·00000

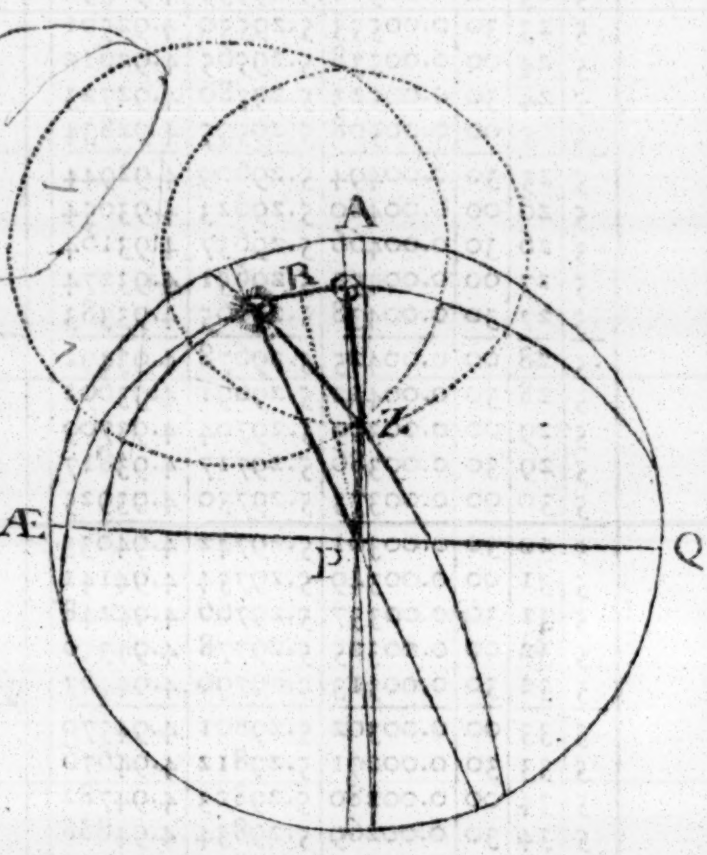
EXAMPLE the First

Of the Preceeding, performed Aſtronomically, which may ſerve as a further Specimen or Proof of the Truth of theſe Tables.

		h. m.		° ′	
The Sun's	1ſt Altitude at	10 02	A.M. =	46 55	Req. the Lat. of the Place, and true Time when each Obſervation was made.
	2d Altitude at	11 27		54 07	
	Declination			11 17 N.	
	Elapſed Time =	01 25			

On the Plane of a Meridian.





In the Right-Angled △ PR☼.

T.co. RP☼ ·· Radius : : S.co.P☼ ·· T.co.P☼R
T. 79° 23′ ·· T. 45° : : S. 11° 17′ ··

19.291504
90 00) 10.727124
02 06) 8.564380

∠ P☼R or P☼⊙ = 87 54
∠ Z☼⊙ - - - = 58 18

∠ P☼Z - - - = 29 36 or Z☼H

Radius .. S.RP☼ : : S.P☼ ·· S.☼R = ⊙R
S. 90° ·· S.10° 37′ : : S. 78° 43′ ··

9.991524
9.265377

10 25/2) 19.256901

☼⊙ = 20 50

In

In the Oblique △ Z ☉ ✺.

° ′

Z ✺ = 43 05 —— S. co. ar. ———— 0.165540
✺ ☉ = 20 50 —— S. co. ar. ———— 0.448976
Z ☉ = 35 53
Sum = 99 48
½Sum = 49 54 —— S. half Sum ——— 9.883617
Rem. - -14 01 —— S. Remainder —— 9.384181
2) 19.882314
9.941157

(60 51
2
121 42
180 00
58 18 = ∠ Z ✺ ☉.

In the Rectangle △ Z H ✺.

T. co. Z✺ ·· Radius : : S. co. Z✺H ·· T. H✺
T. 46° 55′ ·· T. 45 : : S. 60 24 ··
19.939267
10.029078
9.910189

° ′
P ✺ = 78 43)
H ✺ = 39 07)
P H = 39 36

In the two Rectangular △s, ZHP & ZH✺.

S. co. H✺ ·· S. co. PH : : S. co. Z✺ ·· S. co. PZ.
S. 50° 53′ ·· S. 50° 24′ : : S. 46° 55′ ··
9.863538
9.886780
Co. Ar. = 0.110215
19.860533 (46° 30′ Lat.
Latitude by the Tables - - - - - 46° 29′
Difference only = 00 01 min.

In the Right-Angled △ ZHP.

Radius ·· T. co. PZ : : T. PH ·· S. co. ZPH or ZP✺.
T. 45′ ·· T. 46° 30′ : : T. 39° 36′ ··
9.917648
10.022750
19.940398

° ′
(90 00
(60 40
29 20 = 01 57 20 the Hour from Noon.
12 00 00
10 02 40 = Time of firſt Obſervation.
01 25 00 Elapſed Time.
11 27 40 Time of ſecond Obſervation.
By the Watch, which was true Time —— 11 27 00
Difference ———————— 00 00 40 Seconds.

Note. The other Examples thus performed, approach as near the Tables; but theſe would yet come nearer, were they carried to Seconds, and the New Method wrought from a proper Table of Natural Sines, and by taking Proportional Parts.

FINIS.

Edw Bark 1761

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WHEREIN THE

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By W. MOUNTAINE,
Mathematical Examiner to the Honourable the Corporation of
Trinity-Houſe, and Fellow of the *Royal-Society*.

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